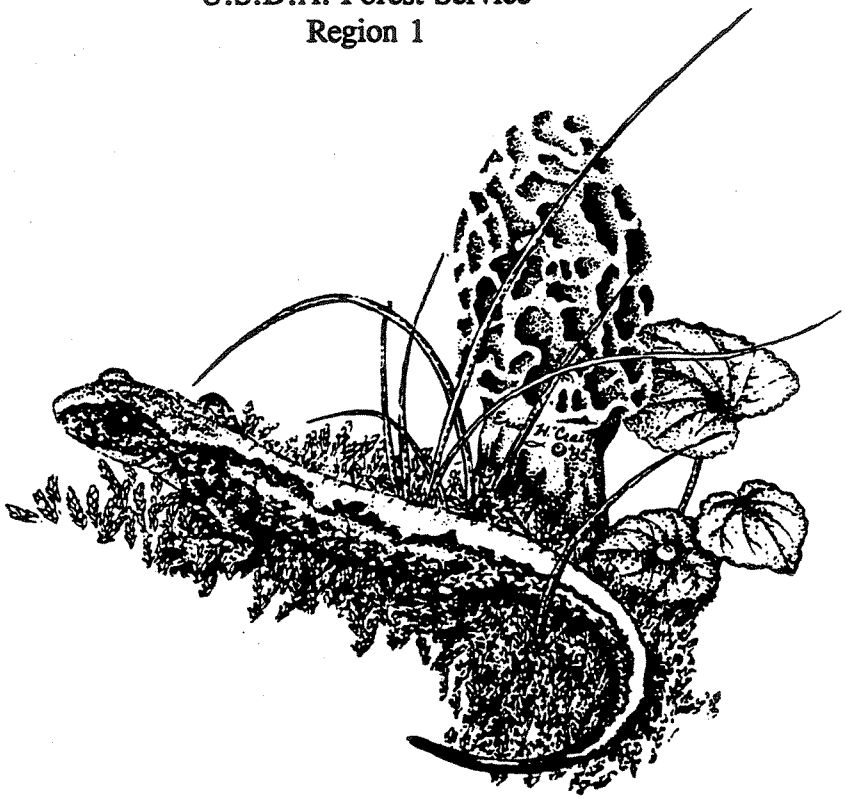
COEUR D'ALENE SALAMANDER CONSERVATION ASSESSMENT

U.S.D.A. Forest Service
Region 1



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August 1994

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FOREWORD

Planning regulations 36 CFR 219.19 and 219.27 for the National Forest Management Act require that National Forest lands be managed to maintain viable populations of all existing native and desired non-native wildlife, fish, and plant species (USDA Forest Service, FSM 2601.2). Forest Service policy defines a viable population as one that has the estimated numbers and distribution of reproductive individuals to ensure persistence of the species throughout its existing range in the planning area, which is one or more identified national forests. Species recognized by the Forest Service as needing special management in order to meet this objective are those designated under the Endangered Species Act as threatened or endangered, candidate species under consideration for such designation, and sensitive species.

Sensitive species are plants and animals identified by the Regional Forester for which population viability is a concern as evidenced by a significant current or predicted downward trend in population numbers or habitat capability that would reduce existing distribution (USDA Forest Service, FSM 2670.5). The Coeur d'Alene salamander (Plethodon idahoensis) was designated a sensitive species in Region 1 of the Forest Service in 1987. Forest Service policy on sensitive species indicates that programs and activities are to be reviewed as part of the NEPA process to determine their potential effects. Management

objectives are to be established in conjunction with states when projects on National Forests may have a significant effect on sensitive species populations.

This conservation assessment has been written to provide guidance needed to better achieve the goals of U.S. Forest Service sensitive species policy. Its purpose is to provide background information on the biology and ecology of the Coeur d'Alene salamander, recommend a monitoring strategy and management guidelines, and suggest areas where research is needed in order to implement more sound management practices.

This assessment will be updated periodically as new information becomes available.

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BIOLOGICAL INFORMATION

Species description

The Coeur d'Alene salamander was first described in 1939 from the northeastern end of Lake Coeur d'Alene in Kootenai County, Idaho (Slater and Slipp 1940). It is one of only four salamander species known to occur in Idaho and Montana, and is the only lungless salamander (Plethodontidae) known from the northern Rocky Mountains (Nussbaum et al. 1983). The salamander is black with a yellowish throat patch and a yellow, orange, green, or red stripe down the middle of the back. The stripe usually has scalloped edges but may have even edges in some animals. It is small, with a maximum snout-vent length (SVL) (body length without tail) of 62 mm (about 2.4 in). Coeur d'Alene salamanders have relatively long legs and short, slightly webbed toes. Females are usually slightly larger than males. Individuals under 44 mm (1.75 in) SVL are sexually immature (Lynch 1984).

The Coeur d'Alene salamander is most easily confused with the long-toed salamander (Ambystoma macrodactylum) by inexperienced observers. The long-toed salamander is the most common salamander in the northern Rockies. It is found in a variety of habitats from sagebrush deserts to alpine meadows often in and around ponds and lakes. Besides occupying different habitats than the Coeur d'Alene salamander, the long-toed salamander lacks a light throat patch and, as its name implies, has longer toes. Pictures of both species can be found in Groves (1989b) (color) and Nussbaum et al. 1983 (black and white).

Status

Based on information suggesting vulnerability due to limited distribution and small population size, the Coeur d'Alene salamander was listed as a Category 2 candidate for threatened or endangered status by the U.S. Fish and Wildlife Service in 1983 (Federal Register 1984). Two ecological studies (Lynch 1984, Lynch and Wallace 1987, Wilson and Larsen 1988), and a number of field surveys (Diller and Wallace 1985; Wilson and Simon 1987; Genter et al. 1988; Groves 1988, 1989a; Groves and Cassirer 1989; Wilson 1990, 1991, 1992) were conducted to provide further information on the biology and distribution of the species. As a consequence of interim surveys, the species was down-listed to Category 3 in 1989 (3C - more widespread or abundant than previously believed) (Federal Register 1989), and subsequently removed from the candidate list in 1991.

The Coeur d'Alene salamander is currently listed as a sensitive species by Region 1 of the U.S. Forest Service and the Idaho state office of the Bureau of Land Management, because of its limited range (it is known only from northern Idaho, northwestern Montana and southern British Columbia), and its specific habitat association (seeps, streams and waterfalls). It is also a state Species of Special Concern in Idaho and Montana (Moseley and Groves 1992, Genter 1992).

Taxonomy

The Coeur d'Alene salamander has been the subject of taxonomic controversy nearly since its initial discovery. Upon first

identification, Slater and Slipp (1940) classified it as a new species, Plethodon idahoensis. Lowe (1950) later reclassified it as a subspecies (idahoensis) of a western Washington Plethodon, Van Dyke's salamander (P. vandykei). Some experts cited biochemical evidence that indicates the Coeur d'Alene salamander is a separate species (Highton and Larson 1979, Wallace 1986), whereas others held that the biochemical evidence is weak, and that insufficient morphological variation exists to justify specific designation (Brodie 1970, Nussbaum et al. 1983). However, whether considered a species or a subspecies, the Coeur d'Alene salamander represents a unique genetic resource in Idaho, Montana, and British Columbia and should be managed as such (Wallace 1986). We follow the most recent classifiction of Collins (1990) which is the species designation (P. idahoensis).

Range and distribution

The Coeur d'Alene salamander is a remnant of a once diverse plethodontid salamander fauna in the northern Rocky Mountains that was likely reduced by climatic changes over the last 10-14 million years (Nussbaum et al. 1983, Tihen and Wake 1983). The species maintains a disjunct distribution at elevations up to 1,524 m (5,000 ft) in northern Idaho, northwestern Montana and southeastern British Columbia. The North Fork of the Clearwater and the St. Joe drainages in Idaho and the lower Clark Fork and Kootenai rivers in Montana comprise the core of the species distribution (Wilson and Simon 1987, Genter et al. 1988; Groves 1988) (Appendix A). The Selway drainage comprises the southern

limit of known range in Idaho (Wilson 1990) and Copper Creek on the Moyie River drainage the northern limit (Wilson et al. 1989) (Appendix B). In Montana, the southern limit of known distribution is Sweathouse Creek in the Bitterroot River drainage (Wilson and Simon 1987) and the northernmost population is along the South Fork of the Yaak River (Appendix C). Coeur d'Alene salamanders are currently known from only three locations in the British Columbia, all along the southeastern corner of Kootenay Lake (49°21'N, 116°44'W) (Holmberg et al. 1984, Orchard 1990, Charland 1992).

A falls, seep, or location along a stream where the species has been observed is considered a Coeur d'Alene salamander site. The Idaho Conservation Data Center catalogs each site separately. The Montana Natural Heritage Program combines groups of sites occurring within 1-3 km (0.6-1.9 mi) that appear to be interconnected by suitable habitat as distinct populations and classifies them as small, medium or large (Appendix C). Keeping in mind these differences in definitions, 192 sites of occurrence have been documented in the U.S., 28 in Montana and 164 in Idaho, (Appendices A, B, C). Ninety-five percent (183) were extant in the latest survey (most were surveyed in 1987 or later by the Montana Natural Heritage Program or the Idaho Conservation Data Center) (Appendices B and C). Nine (5%) are of unknown status (no salamanders found in most recent survey, possibly due to suboptimal survey conditions, or difficulty in finding historical locations). Most known sites or populations (87%) occur on lands

administered by the U.S. Forest Service, but these data are biased by the fact that most surveys have been conducted on National Forest system lands.

Although not all localities of occurrence have been identified, the southern, eastern, and western edges of distribution are likely limited by lack of moisture, discontinuous geologic formations, and high temperatures. Few surveys have been conducted in British Columbia, but the species was likely eliminated from most of the province during the last ice age. The northern limit of current distribution probably represents the extent of successful recolonization of suitable habitat (Lynch 1984).

Life history

Coeur d'Alene salamanders are adapted to a severe environment. The salamanders are usually only above ground at night during moist weather in the spring and fall (Nussbaum et al. 1983), although at some sites salamanders exhibit nocturnal surface activity throughout the summer. Summer surface activity in seeps is negatively correlated with high daytime temperatures and days since last rain (Wilson and Larsen 1988).

Overall, the salamanders may spend up to seven months of the year underground in cool, moist interstitial spaces between rocks to avoid desiccation in summer and freezing in winter. This extensive underground activity presents a major challenge to research and monitoring.

When above ground, Coeur d'Alene salamanders feed primarily on

insects and other invertebrates (Wilson and Larson 1988). They appear to be opportunistic feeders and generally restrict foraging activities to moist spray zones, seeps, or streamside rocks and vegetation although they may venture beyond these areas during rainy periods.

Coeur d'Alene salamanders mate above ground in late summer and fall (August-October) and, to a lesser extent, in spring (April and May) (Lynch 1984). After a courtship ritual of an hour or more, the male deposits a spermatophore with a sperm cap which the female picks up with the cloaca (Lynch and Wallace 1987). Females store sperm up to nine months before fertilizing eggs. An average of six eggs are deposited in April or May, presumably in underground rock crevices, although no nest sites have been found in the wild. The young emerge in mid-September (Lynch 1984).

Neonates apparently grow more slowly than other Plethodon. Growth probably occurs in spurts associated with wet weather in the spring and fall. Male Coeur d'Alene salamanders reach sexual maturity at 3.5 years of age and females at 4.5 years, but some individuals may delay breeding. Males mate every year, while females mate in alternate years (Lynch 1984).

Habitat use

All plethodontid salamanders respire through their skin and lose water to the environment through evaporation and are therefore restricted to cool, damp environments. Because Coeur d'Alene salamanders may live in the harshest climate of any

northwestern Plethodon (Nussbaum et al. 1983), they are highly dependent on the thermal and hydric stability provided by wet habitats in otherwise inhospitable surroundings. For this reason, Coeur d'Alene and Van Dyke's salamanders are closely tied to water and are considered among the most aquatic Plethodon (Brodie and Storm 1970).

Coeur d'Alene salamanders have been found in three major types of habitat: springs or seeps, waterfall spray zones and edges of streams. Seventy-six percent of known locations are classified as seeps, 6% as waterfalls, and 17% as streams. One percent (two sites) are in abandoned mine shafts (Appendices B and C). However, the relative number of locations in each type is biased by differences in survey efficiency and probably does not reflect the importance of the different habitats. The abundance of seep locations is at least partly due to the relative ease of surveying roadside seeps. Streams and waterfalls are often less accessible, particularly at night. Salamanders are most difficult to find in streamside habitat, where they are usually observed underneath moist rocks on the banks adjacent to the water. Searches of 30 minutes to find a salamander at a stream site during daylight are not uncommon (Groves 1988).

Coeur d'Alene salamander sites are generally located in coniferous forest, but are not restricted to a particular overstory species or aspect. Populations have been found in areas with ponderosa pine (Pinus ponderosa), Douglas-fir (Pseudotsuga menziezii), western larch (Larix occidentalis),

western red cedar (Thuja plicata) and western hemlock (Tsuga heterophylla) overstories (Groves 1988) at all aspects.

Ninety percent of 99 Idaho sites where habitat data have been collected were in areas of greater than 25% canopy cover and only two (both seeps) were in an area with 10% cover or less. Forest cover may be more important near stream sites than seep sites. Average cover at streamside sites (83% ± 15%) was significantly greater (Mann-Whitney U, P = 0.005) than at seep locations (57% ± 5%), although only seven stream sites were measured. Minimum canopy cover measured at stream sites was 42%. Terrain at sites was typically steep, with average slopes of 62% (range 10 - 90%) (Groves 1988, Wilson 1991).

Known populations occur in association with sharply fractured rock formations (used for underground refugia) from 488 m (1,600 ft) to 1,524 m (5,000 ft) in elevation. This fractured rock is often found in the Belt Rock formation but can also occur in talus and in other geologic types (Wilson and Simon 1987; Groves and Cassirer 1989). The species is found in conjunction with both persistent and intermittent surface water. Thus, it is possible to locate salamanders at a wet site in the spring, yet be unable to find any animals at the same site later in the summer when the site is dry on the surface.

Conservation genetics

Genetic evidence indicates there is little, if any exchange between widely separated (> 100 km; 62 mi) Coeur d'Alene salamander populations (Wallace 1986). However, the extent of

dispersal between adjacent sites is unknown. Because Coeur d'Alene salamanders are typically aquatic, they are restricted in movements over terrestrial habitats, particularly in arid forests or areas with little canopy cover.

Small, isolated populations are at risk of extinction from four categories of stochastic events: genetic, demographic, environmental, and natural catastrophes. Allendorf and Leary (1986) provide an extensive review of the literature linking heterozygosity and fitness, both in species and populations. Small populations tend to lose variation by genetic drift more rapidly than larger populations (Lacy 1987). Similarly, they are more susceptible to catastrophic events (e.g., fire, floods) which eliminate or alter habitat and kill individuals. Inbreeding in small populations has been shown to contribute to inbreeding depression and lead to numerous deleterious effects (Ralls et al. 1986).

That Coeur d'Alene salamander populations are often small and and apparently isolated (apparently because dispersal capacity is unknown) is of concern for their continued viability. Long-term survival of the species will require preserving the genetic diversity found throughout its range. It is neither feasible nor likely necessary to preserve every population to meet this objective. However, adequate management will require a better understanding of how genetic variation is distributed, within and among populations (Allendorf and Leary 1986).

Recent investigations of geographic variation in the Olympic

salamander (Rhyacotriton olympicus) indicate that it is highly fragmented throughout its range in isolated populations with little or no gene flow among the populations (Good et al. 1987). If such a situation is revealed by genetic analyses of the Coeur d'Alene salamander, the current conservation strategy may need revision to reflect the added significance of unique populations. Of primary concern is that the species retain sufficient genetic variability to allow future evolution. This is particularly true for a relict species which may be limited by several environmental-physiological barriers. Reducing the present genetic variation could restrict the species' ability to respond to changing environmental conditions.

MANAGEMENT

Potential threats and management concerns

There is rising global concern about declining amphibian populations. Amphibians are thought to be sensitive bioindicators of environmental change because of their highly permeable skin, central trophic position, and occurrence in fragmented but interconnected populations (Wake and Morowitz 1990, Wyman 1990). Therefore, status of salamander populations is one indicator of the overall health of an ecosystem. Specific threats to the Coeur d'Alene salamander include: timber harvest, road and trail construction, water diversion projects, pollution, introduction of exotic species, fire, and illegal collecting. Impacts to the salamander should be assessed when any of these activities occur in Coeur d'Alene salamander habitat.

Timber harvest

Timber harvest could potentially affect Coeur d'Alene salamanders in a number of ways including increasing sedimentation, removal of shading, and altering groundwater flow. Sedimentation from logged areas may fill interstitial habitat in and adjacent to streams (Corn and Bury 1989) and render those habitats inaccessible to Coeur d'Alene salamanders or aquatic insects, their primary food (Roby et al. 1977). Removal of overstory canopy could modify water temperature and affect salamanders or their prey (Brown and Krygier 1970). Elimination of canopy cover between salamander sites could reduce or terminate movement of salamanders between sites, increase fragmentation of populations, and, consequently, increase the likelihood of localized extinctions. Finally, on a landscape level, logging (and roading) alter watershed functions by increasing total water yield, increasing peak spring flows, and reducing low summer flows. Post-logging changes in the water table could flood or dry up Coeur d'Alene salamander habitat, even if no activities occur in the immediate vicinity of sites.

Road and trail construction

Sedimentation and watershed alterations caused by road construction could have effects similar to or even worse than that of timber harvest. Blasting or quarrying talus for road construction near seeps can also eliminate habitat and kill salamanders. For salamanders foraging at roadside seeps, traffic mortality may be a factor, although no data are available.

Fire

Although Coeur d'Alene salamanders have evolved in an environment that has periodically burned, elimination of canopy cover between sites by prescribed fire, compounded with logging, could unnaturally terminate exchange of individuals between sites and increase fragmentation and the likelihood of extinction. Prescribed burns in fall and early spring could also disturb breeding activities. Fires may also affect water quality through sedimentation, and chemical changes such as increased levels of nitrogen and phosphorous (Belt et al. 1992).

Water diversion

Alteration of stream flows by dams or diversions may drown salamanders and flood habitat, or dry up downstream sites. Wells could lower the water table and dry up salamander habitat. Blasting associated with water diversion projects could directly kill salamanders and could potentially eliminate subterranean habitat.

Pollution

Salamanders are vulnerable to mortality from pollution such as acid rain and pesticides, herbicides, slurry air drops for fire suppression, or other toxic chemicals, including those in roadside runoff.

Exotic species

Introduction of exotic amphibian, fish or other species could reduce salamander populations if they prey on salamanders (Collins et al. 1988), or compete for food or space.

Illegal collections

Idaho Department of Fish and Game regulations prohibit collecting of Coeur d'Alene salamanders except by permit. In Montana, the salamander is classified as an unprotected nongame species and may be collected without a permit. There appears to be no problem associated with over-collecting or illegal capture of Coeur d'Alene salamanders at this time. However, individual sites may not withstand extensive collecting; this activity will have to be closely monitored by the Forest Service and state wildlife agencies.

Management Guidelines

Although the Coeur d'Alene salamander is locally abundant, it is limited in range and ecological amplitude. Restricted mobility and increasing habitat fragmentation make the Coeur d'Alene salamander susceptible to local extirpation. Sites located off Forest Service land receive little, if any, protection from land management activities. Therefore, special management and attention are necessary to maintain viable populations on National Forest lands.

All Coeur d'Alene salamander sites on National Forest system lands, except for those used in research, will be completely protected from activities which have been listed above as potential threats to the population. To ensure adequate protection, all potential habitat in areas scheduled for timber harvest, road construction, prescribed burns, chemical applications, or stream flow alterations within the known range

of occurrence will be surveyed using methods outlined in this guide prior to project implementation. The following guidelines will be implemented when salamanders are present.

Timber harvest

Timing

Timing of timber harvest around salamander sites will be planned to avoid periods of above-ground salamander activities. Timber harvest will be conducted from November - March. Harvest could also occur during July and August if salamanders are not active above ground at the affected site during this period.

Protection zones

Streamside protection zones can buffer streams from sedimentation, nutrient flow, temperature modifications and flooding caused by timber harvest (Newbold et al. 1980, Murphy et al. 1986, Beschta et al. 1987, Hartman et al. 1987, Belt et al. 1992). Both Idaho and Montana have mandated stream protection zones, as do some Forests. However, the seeps and small, high gradient and intermittent streams that provide most of the known Coeur d'Alene salamander habitat receive minimal protection under these guidelines that are based primarily on protecting downstream water quality, rather than on maintaining high quality on-site habitat in these areas. For instance, the Idaho Forest Practices Act (Title 38, Ch. 13, Idaho Code) denotes a stream protection zone of 1.5 m (5 feet) along headwater or minor drainages (class II streams). The Kootenai Forest Plan (USDA Forest Service 1991) requires streamside management zones of 7.6

m (25 feet) or more on smaller intermittent or ephemeral 33333streams (Class IIIB).

The maximum protection approach (Belt et al. 1992, p. 24) would be best for designing buffer strips at salamander sites. This approach involves calculating the optimum buffer strip characteristics necessary to satisfy each goal of the stream protection zone: elimination of sediment and nutrient flow, maintaining moderate water temperatures, sustaining aquatic invertebrate communities, and conserving groundwater storage. The buffer strip with characteristics which would accomplish all goals is then chosen for the site. Geology, slope, aspect, type of logging and extent of previous logging and roading upstream of the site all influence the size of buffer strip required to accomplish these objectives. In absence of data on the relationships between these factors, a minimum protection zone of 30 m (100 ft) (Newbold et al. 1980) will be maintained around all Coeur d'Alene salamander sites (Table 1). At least 60% canopy cover will be retained in the protection zone over seep sites (Table 1). If 60% canopy cover or less is currently present at a seep then no trees may be removed. Stream and waterfall sites will be protected with a 30-m (100 ft) no-activity buffer on all sides (including both sides of the stream). No slash or prescribed burning will occur in the protection zone, and any trees removed from the seep protection zone will be felled away from the site and understory vegetation will be retained. This protection zone shall be increased where necessary due to

unstable watershed or riparian conditions, or previous degradation of sites. Adequacy of these protection zones will be evaluated (see research section) and modified as appropriate.

Table 1. Site management guidelines for the Coeur d'Alene salamander on National Forest lands.

Site type	Protection zone requirements	Timing restrictions
Seep	30 m (100 ft) buffer around site, maintain canopy cover of 60%, leave understory vegetation, no heavy equipment in buffer, fell logs away from salamander site and remove with winchlines and cables, no burning in buffer, no pesticide or herbicide application. No roads in buffer, roads above sites located at least 100 m (328 ft) from site, leave talus at base of road cuts.	Logging units containing salamander sites harvested in November-March if possible, or in July or August. Prescribed burns or chemical applications in areas surrounding salamander sites scheduled in July or August.
Stream or waterfall	same as seep except no logging to occur in buffer	same as seep

Watershed management

Watershed guidelines on the Idaho Panhandle National Forest (review draft, Idaho Panhandle National Forests 1992) and the Kootenai National Forest (S. R. Johnson, pers. comm.) include recommendations for limiting increases in peak (spring) flows to 0-20% depending on channel stability using the following guidelines:

Harvest: Avoid concentration of harvest activities in headwater subdrainages.

Use partial cutting which maintains 85% of pre-harvest canopy cover or greater.

Scatter openings and limit size to 0.2 ha (0.5 acres).

Maintain buffers of 30 m (100 ft) along all streams and provide for recruitment and retention of woody debris in the stream and riparian area.

Encourage winter logging as well as use of FMC type low ground pressure tracked vehicles.

Roads: Minimize road construction, and avoid roads up drainage bottoms, concentrate road systems on mid-slope or ridges. Restrict frequency of stream crossings, provide adverse grades in and out of stream crossing and where feasible, bridge streams instead of using culverts.

Provide adequate drainage including frequent relief culverts, capable of passing 50-year flood events with no head in the culvert inlet.

Avoid building roads in unstable land types.

Maintain roads and use seasonal road closures to prevent deterioration.

All watersheds containing Coeur d'Alene salamanders on National Forest system lands should be managed in accordance with these guidelines. Headwater drainages and subdrainages in particular should be protected because these are often where salamander habitat is located and effects of logging activities

may be magnified in these areas. Detrimental conditions in headwaters will also affect downstream habitat (Bury et al. 1991a). Watersheds already showing signs of stress (condition yellow) as determined by an index such as the Riffle Armor Stability Index (RASI) (Idaho Panhandle National Forests 1992) or by professional judgement, should be managed so that increases in normal peak runoff due to management activities will be no greater than 5%. No increases in normal peak runoff as a result of management activities should occur in watersheds out of equilibrium (condition red).

Road and trail construction

Forest Service roads will be routed around salamander sites. To minimize sedimentation and disturbance, roads located above salamander sites will be located no closer than 100 m (328 ft) (Ketcheson and Megahan 1990); roads located below salamander sites will be located no closer than 30 m (100 ft). No road widening will be undertaken that might impact current populations or habitat. Talus rubble will be left at the base of road cuts near salamander sites to provide cover and foraging habitat.

State and federal agency biologists will work closely with state highway departments to achieve similar management objectives on non-Forest Service lands.

Fire

Slash burns adjacent to salamander sites will be conducted in July and August to minimize disturbance to habitat, movements, and breeding activities in the spring and fall. Protection zones

(30 m; 100 ft) around salamander sites will not be burned. Prescribed burns within watersheds known to contain Coeur d' Alene salamanders should be avoided if possible, particularly in areas upstream to known locations.

Chemical applications

Toxic chemicals that will enter the surface or ground water at or near known Coeur d'Alene salamander sites should not be applied. Nontoxic chemicals that could potentially reach salamander sites will be applied during dry periods in July and August when salamander above-ground activity is reduced. Forest Service personnel will furnish information on location of roadside salamander sites to county weed control specialists, where applicable, in order to avoid spraying these areas.

Water diversion

No dams or water diversions shall be constructed which could flood or dessicate Coeur d'Alene salamander sites.

MONITORING

To assure the maintenance of viable populations of Coeur d'Alene salamanders across their range, a comprehensive monitoring program will be initiated. Regular population and habitat assessment provides valuable information on causal mechanisms and effects of various disturbances. For salamanders, these may be global (climate change), regional (acid precipitation, air quality), or local (fire, timber harvest, road or hydro development). It is particularly important to monitor populations in a managed landscape to assess various impacts of

land management activities.

Plethodontid salamanders have proven difficult to monitor for population size and trends (Genter et al. 1991, Scott and Ramotnik 1992). Surveys themselves can also be destructive to salamander habitat. We recommend a comprehensive monitoring agenda that addresses trends in habitat condition, presence or absence of salamanders, and possible trends in population size and status, while minimizing monitoring effects on salamander habitat.

Monitoring for the overall persistence of the Coeur d'Alene salamander (Table 2) will be accomplished by annually surveying sites in selected, accessible, areas of occurrence distributed

Table 2. Sites to monitor annually (nonintrusively) for Coeur d'Alene salamanders.

Site name	Location	Forest	Ranger District
Lochsa River	T34N, R8E	Clearwater	Lochsa
Quartz Creek	T40N, R8E	Clearwater	North Fork
Quartz Creek, 161	T40N, R8E	Clearwater	North Fork
Rock Creek	T40N, R6E	Clearwater	North Fork
N. Fk. Clearwater, 159	T41N, R7E	Clearwater	North Fork
N. Fk. Clearwater, 160	T41N, R7E	Clearwater	North Fork
St. Joe River #2	T45N, R4E	St. Joe	Avery
St. Joe River #3	T45N, R4E	St. Joe	Avery
St. Joe River #4	T45N, R5E	St. Joe	Avery
Koocanusa - north	T34N, R29W	Kootenai	Rexford
Kootenai Falls - east	T31N, R32W	Kootenai	Libby
Kootenai Falls - west	T31N, R33W	Kootenai	Three Rivers

across the species' range. Sites will be located and flagged during daylight, prior to surveys. Flagging will be removed when surveys are completed. During the first year of surveys, Forest Service personnel will take pictures of each survey site, delineate on the pictures the specific area to be surveyed along with a hand-drawn sketch of the site, and provide detailed directions (with map) on how to get to the survey site(s) in a permanent file.

Surveys will be conducted in the evening (after sunset) during the cool, wet periods of May through June during or one day after rain, when evening air temperatures are above 7°C (48°F). Searches will be conducted by looking on rocks, moss, woody debris and in rock crevices with illumination within a specific measured area containing the known site of occurrence. Impacts to sites from monitoring will be minimized by not moving rocks, moss and other material during the search. Only animals located on the surface will be counted.

Time-constrained surveys will be conducted at each site (Corn and Bury 1990). For small seeps whose total wet area can be seen by one person standing in one place (e.g. < 100 m^2; 1,075 ft^2), surveys should be conducted for 20 person-minutes (one person for 20 minutes or two people for 10 minutes). For larger seeps or sites that might consist of a small cascading stream and adjacent wet areas, searches will be conducted for 40-person minutes (Table 3). Efforts should be made to survey all moist habitat at each site.

The following information will be noted for each survey site: site name, location (TRS), date, time, air temperature (start and finish), water temperature, area of habitat (measure with tape during daylight if possible), number of salamanders greater than 44 mm (1.75 in.) SVL (adults), number of salamanders less than 44 mm (1.75 in.) SVL (juveniles), area searched (if different than area of habitat), time spent searching (20 versus 40 minutes), name(s) of observer(s), and comments on disturbance to site (see Appendix D for survey/monitoring form). Monitoring forms will be sent to the Montana Natural Heritage Program or the Idaho Conservation Data Center, as appropriate. This monitoring is designed primarily to measure salamander presence/absence. Although population trend may be suggested based on numbers of salamanders found under controlled conditions during a time-constrained search, this cannot be validated with the current data available and will be the subject of research investigations (described below).

Sites of occurrence where salamanders are not found will be revisited during spring or during late September or early October in similar weather conditions. Searches will be conducted as discreetly as possible. Locations of salamander sites should not be published or widely distributed to avoid potential impacts from indiscriminate collecting or vandalism.

In addition to annual surveys at selected sites, all known sites will be monitored every 10 years. Search protocol will be similar to that of annual searches except that searches will also

include looking for salamanders under rocks, moss and logs, and stream sites will be surveyed for 40 minutes (Table 3). If no salamanders are found at a site, searches will be conducted again the following year and each subsequent year until the site is verified, or determined to be extirpated (at least five consecutive years of proper examination).

Survey and monitoring at sites in areas already scheduled for logging or other management activities will be incorporated into the biological evaluation of the management activity. Sites will be monitored at least one year prior to and three consecutive years after activities occur (Table 3). These sites will then continue to be monitored at 10-year intervals under the extensive monitoring protocol. This monitoring will be incorporated into research on the effects of timber harvest on the salamander.

RESEARCH

Although much has been learned about the Coeur d'Alene salamander in the last decade, several management questions have yet to be answered. Specific questions critical to effective management of this species by the Forest Service are:

1. methods of reliable population estimation;
2. effects of timber harvest and other management activities;
3. movements of individuals and genetic variability among sites.

This research can be accomplished cooperatively by the National Forests and the Forest Service Research Stations and/or

Table 3. Monitoring schedule and guidelines for Coeur d'Alene salamander sites.

Type	Interval	Criteria	Methodology
Nonintrusive	annually	selected accessible sites located across the species' range	Nocturnal searches of the surface during spring or fall, during or one day after rain, nighttime temperatures above 7°C (48°F), for 20-40 minutes per site
Extensive	every 10 years	all sites	same environmental conditions as for nonintrusive searches but include moving surface material to look for salamanders under rocks, logs or vegetation, stream sites surveyed for 40 minutes
Experimental and control	1 year before and annually for 3 years after management activities occur, then included in extensive surveys	sites potentially affected by logging or other management activities	same as extensive surveys

through contracting with universities, Natural Heritage Programs, or other qualified organizations.

Population size estimation

Determining the number of Coeur d'Alene salamanders at a site is not straight forward. Substantial habitat exists underground and not all or even a fixed percentage of salamanders are above ground on any given night. In some cases, underground habitat availability may be more limiting to salamanders than above-ground conditions (Genter et al. 1988).

One potential method of population estimation would involve establishing a rarefaction experiment by carefully removing salamanders under controlled conditions from selected sites and holding them (preferably in a facility in the field) until no more salamanders are found at the site (Groves 1989a). A curve could then be established based on diminishing returns as the salamanders are removed, whereby the actual number of salamanders at a site could eventually be predicted from a few nights of removals.

During application of this procedure as a mitigation measure for major highway construction at U.S. Highway 2 near Libby, Montana, during the fall of 1988 (Genter 1989) the curve had only a small negative slope over seven nights of collecting. There were two factors that seemed to complicate the population estimate: drought and early, cold temperatures. The combination of these adverse conditions would limit the number of salamanders out foraging or breeding on any given night. Thus, temperature,

humidity and rainfall measurements would have to be incorporated into any rarefaction experiment. The characteristics of the site may have also influenced the results in this case. The site is large, with extensive areas of interconnected, potential habitat. This population estimation technique may be more effective in smaller, isolated populations with less possibility of immigration of salamanders from surrounding areas during removal.

Mark-recapture by clipping toes has also been used to estimate population size at some sites but has been found to be of limited value (Lynch 1984). Mark-recapture has been difficult to effectively employ with western Plethodon, largely due to the regeneration of small appendages (B. Bury, pers. comm.). Lynch (pers. comm.) and Groves (unpubl. data) found that marking by clipping feet resulted in apparent high rates of mortality in the Coeur d'Alene salamander. Some other methods that have been successfully used to individually mark eastern Plethodon are subcutaneous injection of acrylic polymer (Woolley 1973, Gergits and Jaeger 1990) and application of powdered flourescent pigment (Nishikawa and Service 1988, Nishikawa 1990). PIT tags may also offer potential for marking adult Coeur d'Alene salamanders, although initial experiments have not been promising (Wilson, unpubl. data). Experimentation on captive animals and further literature review should be conducted to explore marking techniques. These marking techniques are needed not only for estimating numbers, but also to obtain estimates of annual fecundity and mortality for population viability assessments.

Methods of population estimation conducted in the wild should be limited to select, dense populations in the North Fork of the Clearwater and St. Joe River drainages in Idaho and along the Kootenai River drainage in Montana.

Effects of timber harvest

Studies of the effects of timber harvest on amphibians in the states of Washington, Oregon and California indicate that some species of salamanders are associated with older forests and are absent or less abundant in logged areas (Bury 1983, Bury and Corn 1988a, Herrington and Larsen 1985, Raphael 1988, Welsh 1990, Bury et al. 1991b). Some species, such as the Olympic salamander (Rhyacotriton olympicus) probably cannot persist in clear-cut areas and must recolonize from adjacent forested sites (Bury and Corn 1988b). The primary immediate habitat changes associated with logging that affect amphibians associated with streams appear to be: changes in water temperature, increased sedimentation, changes in invertebrate populations (Bury and Corn 1988b) and alterations in stream flow and water table. The degree to which these affect amphibian populations varies with stream gradient, geomorphology, climate and the adaptability of the species or population (Hall et al. 1978, Murphy et al. 1981, Good et al. 1987).

Groves (1988) noted that some populations of Coeur d'Alene salamanders appeared to persist after logging activity, at least in the first few years following harvest activities. Different types of populations (seeps, streams and falls) may differ in

Table 4. Partial list of Coeur d'Alene salamander habitat in scheduled timber sale areas.

Site Name	Forest	District
Cedar Creek	St. Joe	Avery
Kyle Creek	St. Joe	Avery
Siwash Creek	St. Joe	Avery
Blue Grouse	St. Joe	Avery
Sister's Creek	St. Joe	Avery
Beaver Creek	Clearwater	North Fork
Broom Creek	Clearwater	North Fork
Cougar Creek	Clearwater	North Fork
Dog Creek	Clearwater	North Fork
Fix Creek	Clearwater	North Fork
Grizzly Creek	Clearwater	North Fork
Hidden Creek	Clearwater	North Fork
Len Creek	Clearwater	North Fork
Leuty Creek	Clearwater	North Fork
Pear Creek	Clearwater	North Fork
Quartz Creek	Clearwater	North Fork
Raft Creek	Clearwater	North Fork
Rock Creek	Clearwater	North Fork
Salmon Creek	Clearwater	North Fork
Sourdough Creek	Clearwater	North Fork
Sousie Creek	Clearwater	North Fork
Steep Creek	Clearwater	North Fork
Syringa Creek	Clearwater	North Fork

their tolerance of logging activity, and various logging practices probably have different effects on salamanders and salamander habitat. Effects of logging should be examined by

surveying sites (Table 4) under different harvest regimes for salamander presence before and after scheduled timber sales (Table 3). Adjacent unlogged populations in similar habitat types should be protected and monitored as controls.

Several known Coeur d'Alene salamander populations have already been exposed to logging (Table 5). These should continue to be regularly monitored. Surveys could also be conducted to examine current salamander presence in logged and unlogged drainages. Concurrent data should be collected on timber management technique (clearcut, select cut, buffer width), percent of drainage logged, water temperature, ambient temperature, substrate size, cobble embeddedness, canopy cover, slope, stream gradient and aspect.

Table 5. Known Coeur d'Alene salamander sites that have been logged.

Site Name	Type	Ownership
Bird Creek/St. Joe River	stream	ST. JOE N.F.
Benton Creek	seep	ARMY CORPS
Benton Butte	seep	ID DEPT LANDS
W. Fork Benton Cr.	stream	POTLATCH
Big Hoodoo Mtn.	stream	KOOTENAI N.F.
Big Hole Peak	seep	LOLO N.F.

Movements and dispersal

Determining the extent of movements of salamanders among sites is

critical to understanding the population dynamics and stability of the species. For instance, what is the potential for recolonization of impacted sites? How important are habitat conditions between sites (corridors) for dispersal? How does elimination of a site contribute to genetic isolation of adjacent sites? What contribution does each site make to the viability of the metapopulation? These questions could be addressed by a study of the genetic relatedness of salamanders within a site and among sites. Such a study has been initiated by the Montana Natural Heritage Program in cooperation with the University of Montana. Other possible methods include marking and following individuals at sites in close proximity (see population estimation section for discussion of marking), or attempting to remove all salamanders from selected sites and examining recolonization rates.

IMPLEMENTATION AND REVIEW

Nez Perce National Forest

ANNUALLY (beginning in 1994)

1. Conduct clearance surveys and implement monitoring for projects in potential Coeur d'Alene salamander habitat.

1997

2. Begin 10-year monitoring.

Clearwater National Forest

ANNUALLY (beginning in 1994)

1. Conduct nonintrusive monitoring at selected sites along the North Fork Clearwater River on the North Fork Ranger District and the Lochsa River on the Lochsa District.
2. Conduct clearance surveys and implement monitoring for projects in potential Coeur d'Alene salamander habitat.

1994

3. Confer with Idaho Conservation Data Center on potential sites for population estimation and movements.

1997

4. Begin 10-year monitoring.

Idaho Panhandle National Forests

ANNUALLY (beginning in 1994)

1. Conduct nonintrusive monitoring at selected sites along the St. Joe River on the Avery Ranger District.
2. Conduct clearance surveys and implement monitoring for projects in potential Coeur d'Alene salamander habitat.

1994

3. Confer with Idaho Conservation Data Center on potential sites for population estimation and movements.

1997

4. Begin 10-year monitoring.

Kootenai National Forest

ANNUALLY (beginning in 1994)

1. Monitor sites along Koocanusa Reservoir on the Rexford Ranger District and Kootenai Falls on the Libby and Three Rivers Ranger Districts.
2. Conduct clearance surveys and implement monitoring for projects in potential Coeur d'Alene salamander habitat.

1997

3. Begin 10-year monitoring at all sites.

Lolo National Forest

ANNUALLY (beginning in 1994)

1. Conduct clearance surveys and implement monitoring for projects in potential Coeur d'Alene salamander habitat.

1997

2. Begin 10-year monitoring at all sites.

Bitterroot National Forest

ANNUALLY (beginning in 1994)

1. Conduct clearance surveys and implement monitoring for projects in potential Coeur d'Alene salamander habitat.

1997

2. Begin 10-year monitoring at all sites.

Regional Office, MTNHP, IDCDC

1994-1995

1. Organize collection and analysis of data on effects of logging and other management activities.
2. Initiate work on population estimation.
3. Initiate/continue studies of movements and genetic relatedness among sites.

DE-LISTING AS SENSITIVE SPECIES

Once the management guidelines outlined in this assessment have been officially accepted (with written documentation) and implemented at the Forest level, consideration could be given to declassifying the Coeur d'Alene salamander as a sensitive species. However, such a declassification should only take place if the salamander appears to be maintaining widely distributed, abundant populations as revealed through population monitoring. Before delisting, the Forest Service should consult with appropriate personnel in the Idaho Conservation Data Center and the Montana Natural Heritage Program.

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LITERATURE CITED

Allendorf, F.W. and R.F. Leary. 1986. Heterozygosity and fitness in natural populations of animals. Pp. 57-76 in Conservation biology: the science of scarcity and diversity. M. E. Soule, ed. Sinaeur Assoc., Sunderland, MA.

Belt, G.H., J. O'Laughlin and T. Merrill. 1992. Design of forest riparian buffer strips for the protection of water quality: analysis of scientific literature. Id. For., Wildl. and Range Policy Analysis Group, Id. For., Wildl., and Range Exp. Sta., Univ. of Idaho, Moscow. Rept. No. 8. 34 pp.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby and T.D. Hofstra. 1987. Stream temperatures and aquatic habitat: fisheries and forestry interactions. Pp. 191-232 in E.O. Salo and T.W. Cundy, eds. Streamside management: Forestry and fishery interactions. Contrib. 57, Inst. For. Resour., Univ. Wash., Seattle. 471 pp.

Brodie, E.D. 1970. Western salamanders of the genus Plethodon: systematics and geographic variation. Herpetologica 26:468-516.

_____ and R.M. Storm. 1970. Plethodon vandykei. Soc. for the Study of Amph. and Rept., Cat. Amer. Amph. and Rept.: 91.1-91.2

Brown, G.W. and J.T. Krygier. 1970. Effects of clear-cutting on stream temperature. Water Resources Res. 6:1133-1139.

Bury, R.B. 1983. Differences in amphibian populations in logged and old growth redwood forest. Northwest Sci. 57:167-178.

_____. and P.S. Corn. 1988a. Douglas-fir forests in the Oregon and Washington Cascades: relation of the herpetofauna to stand age and moisture. Pp. 11-22 in Management of amphibians, reptiles and small mammals in North America. USDA Forest Service Gen. Tech. Rept. RM-166.

_____ and _____. 1988b. Responses of aquatic streamside amphibians to timber harvest: a review. Pp. 165-181 in K. J. Raedeke, ed. Streamside management, riparian wildlife and forestry interactions. Contribution No. 59, Institute of Forest Resources, University of Washington, Seattle.

_____, _____, K.B. Aubry, F.F. Gilbert and L.L.C. Jones. 1991a. Aquatic amphibian communities in Oregon and Washington. Pp. 353-362 in L.F. Ruggerio, ed. Wildlife and vegetation of unmanaged Douglas-fir forests. USDA Forest Service, Gen. Tech. Rept. PNW-GTR-285.

_____, _____, and _____. 1991b. Regional patterns of terrestrial amphibian communities in Oregon and Washington. Pp. 341-350 in L.F. Ruggerio, ed. Wildlife and vegetation of unmanaged Douglas-fir forests. USDA Forest Service, Gen. Tech. Rept. PNW-GTR-285.

Charland, M.B. 1992. A survey of the distribution and biology of the Coeur d'Alene salamander (*Plethodon vandykei idahoensis*) in British Columbia. Wildlife Branch, Ministry of Environment, Lands, and Parks, Victoria, B.C. Draft report. 32 pp.

Collins, J.T. 1990. Standard common and current scientific names for North American amphibians and reptiles. Third ed. Soc. for the Study of Amph. and Rept. Circ. 19:1-41.

Collins, J.P., T.R. Jones and H.J. Berna. 1988. Conserving genetically distinct populations: the case of the Huacha tiger salamander (Ambystoma tigrinum stebbinsi Lowe). Pp. 45-53 in R.C. Szaro, K.E. Sieverson and D.R. Patton, eds. Management of amphibians, reptiles, and small mammals in North America. Gen. Tech. Rept. RM-166, USDA Forest Service, Rocky Mountain Station, Ft. Collins, Co.

Corn, P.S. and R.B. Bury. 1989. Logging in western Oregon: responses of headwater habitats and stream amphibians. For. Ecol. Manage. 29:39-57.

_____ and _____. 1990. Sampling methods for terrestrial amphibians and reptiles. USDA Forest Service, Pacific Northwest Research Station, Gen. Tech. Rept. PNW-GTR-256.

Diller, L. and R. Wallace. 1985. Report on a survey on the Selway-Bitterroot wilderness for the Coeur d'Alene salamander, Plethodon vandykei. USDA Forest Service, Moose Creek District. 5 pp.

Genter, D.L. 1989. Mitigation of the Kootenai Falls population of the Coeur d'Alene salamander. Report to Montana Dept. Highways and USDA Forest Service. Montana Natural Heritage Program, Helena, MT. 11 pp.

_____. 1992. Animal Species of Special Concern in Montana. Montana Natural Heritage Program, Helena, MT. 11 pp.

_____ , A. G. Wilson, and E.M. Simon. 1988. Supplementary report on the status of the Coeur d'Alene salamander (Plethodon vandykei idahoensis) in Montana. Montana Natural Heritage Program, Helena, MT. 40 pp.

_____, D.L., R. Summerfield, and M. Hunnicutt. 1991. Results of population monitoring for the Coeur d'Alene salamander

(Plethodon idahoensis) in northwestern Montana. Montana Natural Heritage Program, Helena, MT.

Gergits, W.F. and R.G. Jaeger. 1990. Site attachment by the Red-backed salamander, Plethodon cinereus. J. Herpetol. 24:91-93.

Good, D.A., G.Z. Wurst and D.B. Wake. 1987. Patterns of geographic variation in allozymes of the Olympic salamander, Rhyacotriton olympicus (Caudata: Dicamptodontidae). Fieldiana Zool. New Ser. 32:1-15.

Groves, C.R. 1988. Status and distribution of the Coeur d'Alene salamander (Plethodon vandykei idahoensis) in Idaho. Idaho Dept. of Fish and Game, Nongame and Endang. Wildl. Prog. 59 pp.

_____. 1989a. Status and distribution of the Coeur d'Alene salamander (Plethodon vandykei idahoensis) in Idaho - Part II. Idaho Dept. of Fish and Game, Nongame and Endang. Wildl. Prog. 19 pp.

_____. 1989b. Idaho's amphibians and reptiles: description, habitat and ecology. Idaho Dept. of Fish and Game, Nongame Leaflet No. 7. 12 pp.

_____ and F. Cassirer. 1989. A survey of the Katka-Boulder and Horizon analysis areas, Idaho Panhandle National Forest, for the Coeur d'Alene salamander (Plethodon vandykei idahoensis). Idaho Dept. of Fish and Game, Nongame and Endang. Wildl. Prog. 13 pp.

Hall, J.D., M.L. Murphy and R.S. Aho. 1978. An improved design for assessing impacts of watershed practices on small streams. Verh. Internat. Verein. Limnol. 20:1359-1365.

Hartman, G., J.C. Scrivener, L.B. Holtby and L. Powell. 1987. Some effects of different streamside treatments on physical conditions and fish population processes in Carnation Creek, a coastal rain forest stream in British Columbia. Pp. 330-372 in E.O. Salo and T.W. Cundy, eds. Streamside management: Forest and fishery interactions. Contrib 57, Inst. For. Resour., Univ. Wash., Seattle. 471 p.

Herrington, R.E. and J.H. Larsen, Jr. 1985. The current status, habitat requirements, and management of the Larch Mountain salamander. Biol. Conserv. 34:169-179.

Highton, R. and A. Larson. 1979. The genetic relationships of salamanders of the genus Plethodon. Syst. Zool. 28:579-599.

Holmberg, R.G., N.P.D. Angerilli and L.J. LaCasse. 1984. Overwintering aggregations of Leiobunum paessleri in caves and mines (Arachnida, Opiliones). J. Arachnol. 12:195-204.

Idaho Panhandle National Forests. 1992. Implementation guidelines and stream channel evaluations for the Forest Plan. Review Draft 9/30/92.

Ketcheson, G.L. and W.F. Megahan. 1990. Sediment deposition on slopes below roads in the Idaho batholith. USDA Forest Service, Intermountain Forest and Range Experiment Sta., Boise, ID 16 pp.

Lacy, R.C. 1987. Loss of genetic diversity from managed populations: interacting effects of drift, mutation, selection, and population subdivision. Cons. Biol. 1:143-158.

Lowe, C.H., Jr. 1950. The systematic status of the salamander Plethodon hardii, with a discussion of biogeographical problems in Aneides. Copeia 1950:92-99.

Lynch, J.E. 1984. Reproductive ecology of Plethodon idahoensis. M.S. Thesis, Univ. of Idaho, Moscow. 59 pp.

_____ and R.L. Wallace. 1987. Field observations of courtship behavior in Rocky Mountain populations of Van Dyke's salamander, Plethodon vandykei, with a description of its spermatophore. J. Herp. 21:337-340.

Moseley, R. and C. Groves. 1992. Rare, threatened and endangered plants and animals of Idaho. Natural Heritage Sect. Nongame and Endang. Wildl. Prog., Idaho Dept. of Fish and Game. 38 pp.

Murphy, M.L., C.P. Hawkins and N.H. Anderson. 1981. Effects of canopy modification and accumulated sediment on stream communities. Trans. Am. Fish. Soc. 110:469-478.

_____, J. Heifetz, S.W. Johnson, K.V. Koski and J.K. Thedinga. 1986. Effects of clear-cut logging with and without buffer strips on juvenile salmonids in Alaskan streams. Can. J. Fish. Aquat. Sci. 43:1521-1533.

Newbold, J.D., D.C. Erman and K.B. Roby. 1980. Effects of logging on macroinvertebrates in streams with and without buffer strips. Can. J. Fish. Aquat. Sci. 37:1076-1085.

Nishikawa, K.C. 1990. Intraspecific spatial relationships of two species of terrestrial salamanders. Copeia 1990:418-426.

_____ and P.M. Service. 1988. A fluorescent marking technique for individual recognition of terrestrial salamanders. J. Herpetol. 22:351-353.

Nussbaum, R.A., E.D. Brodie and R.M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. Univ. Idaho Press, Moscow. 332 pp.

Orchard, S.A. 1990. Provincial status report for the Coeur d'Alene salamander Plethodon idahoensis. Wildlife Branch, Ministry of Environment, Lands, and Parks, Victoria, B.C. Draft report. 12 pp.

Ralls, K., P.H. Harvey and A.M. Lyles. 1986. Inbreeding in natural populations of birds and mammals. Pp. 35-56 in Conservation biology: the science of scarcity and diversity. M.E. Soule, ed. Sinaeur Assoc., Sunderland MA.

Raphael, M.G. 1988. Long term trends in abundance of amphibian, reptiles, and small mammals in Douglas-fir forests of northwestern California. Pp. 23-31 in R.C. Szaro, K.E. Sieverson and D.R. Patton, eds. Management of amphibians, reptiles, and small mammals in North America. Gen. Tech. Rept. RM-166, USDA Forest Service, Rocky Mountain Station, Ft. Collins, Co.

Roby, K.B., D.C. Erman and J.D. Newbold. 1977. Biological assessment of timber management activity impacts and buffer strip effectiveness on National Forest streams of Northern California. USDA Forest Service Region 5, Monograph 1.

Scott, N.J. Jr. and C.A. Ramotnik. 1992. Does the Sacramento salamander require old-growth forests? Pp. 170-178 in Kaufmann, M.R., W.H. Moir and R.L. Bassett, tech. coord. Old-growth forests in the southwest and Rocky mountain regions, proceedings of a workshop. USDA Forest Service Gen. Tech. Rept. RM-213.

Slater, J.R. and J.W. Slipp. 1940. A new species of Plethodon from northern Idaho. Occas. Papers Dept. Biol. Coll. of the Puget Sound. 8:38-43.

Tihen, J.H. and D.B. Wake. 1981. Vertebrae of plethodontid salamanders from the lower Miocene of Montana. J. Herp. 15:35-40.

USDA Forest Service. Forest Service Manual, Title 2600 and 2670. Wildlife, Fish, and sensitive plant habitat management. USDA Forest Service, Washington D.C.

_____ 1991. Riparian Area Guidelines. Appendix 26 in Kootenai National Forest Plan, Kootenai National Forest, Libby, MT.

Wake, D.B. and H.J. Morowitz. 1990. Findings and recommendations in Declining amphibian populations - A global phenomenon? National Research Council Workshop, Irvine, CA.

Wallace, R.L. 1986. A biochemical genetic study of the Plethodon vandykei complex. Idaho Dept. of Fish and Game, Nongame and Endang. Wildl. Prog. 30 pp.

Welsh, H.H. 1990. Relictual amphibians and old-growth forests. Cons. Biol. 4:309-319.

Wilson, A.G. Jr. 1990. A survey of the Nez Perce National Forest for the Coeur d'Alene salamander (Plethodon idahoensis). Idaho Dept. of Fish and Game, Nongame and Endang. Wildl. Prog. 33 pp.

_____. 1991. A survey of the Avery Ranger District, Panhandle National Forest, for the Coeur d'Alene salamander (Plethodon idahoensis). Idaho Dept. of Fish and Game, Nongame and Endang. Wildl. Prog. 44 pp.

_____. 1992. A survey of the St. Maries and Sandpoint Ranger Districts, Panhandle National Forest, for the Coeur d'Alene salamander (Plethodon idahoensis). Idaho Dept. of Fish and Game, Nongame and Endang. Wildl. Prog. 28 pp.

_____ and J.H. Larsen, Jr. 1988. Activity and diet in seepage-dwelling Coeur d'Alene salamanders (Plethodon vandykei idahoensis). Northwest Sci. 62:211-217.

_____ and Simon, E.M. 1987. Status of the Coeur d'Alene salamander (Plethodon vandykei idahoensis) in Montana. Montana Natural Heritage Program, Helena, MT. 134 pp.

_____, _____ and J.H. Larsen, Jr. 1989. Range extension for the Coeur d'Alene salamander, Plethodon vandykei idahoensis, to the Canada-United States border. Can. Field-Nat. 103:93-94.

Woolley, H. P. 1973. Subcutaneous acrylic polymer injections as marking technique for amphibians. Copeia 2:1973.

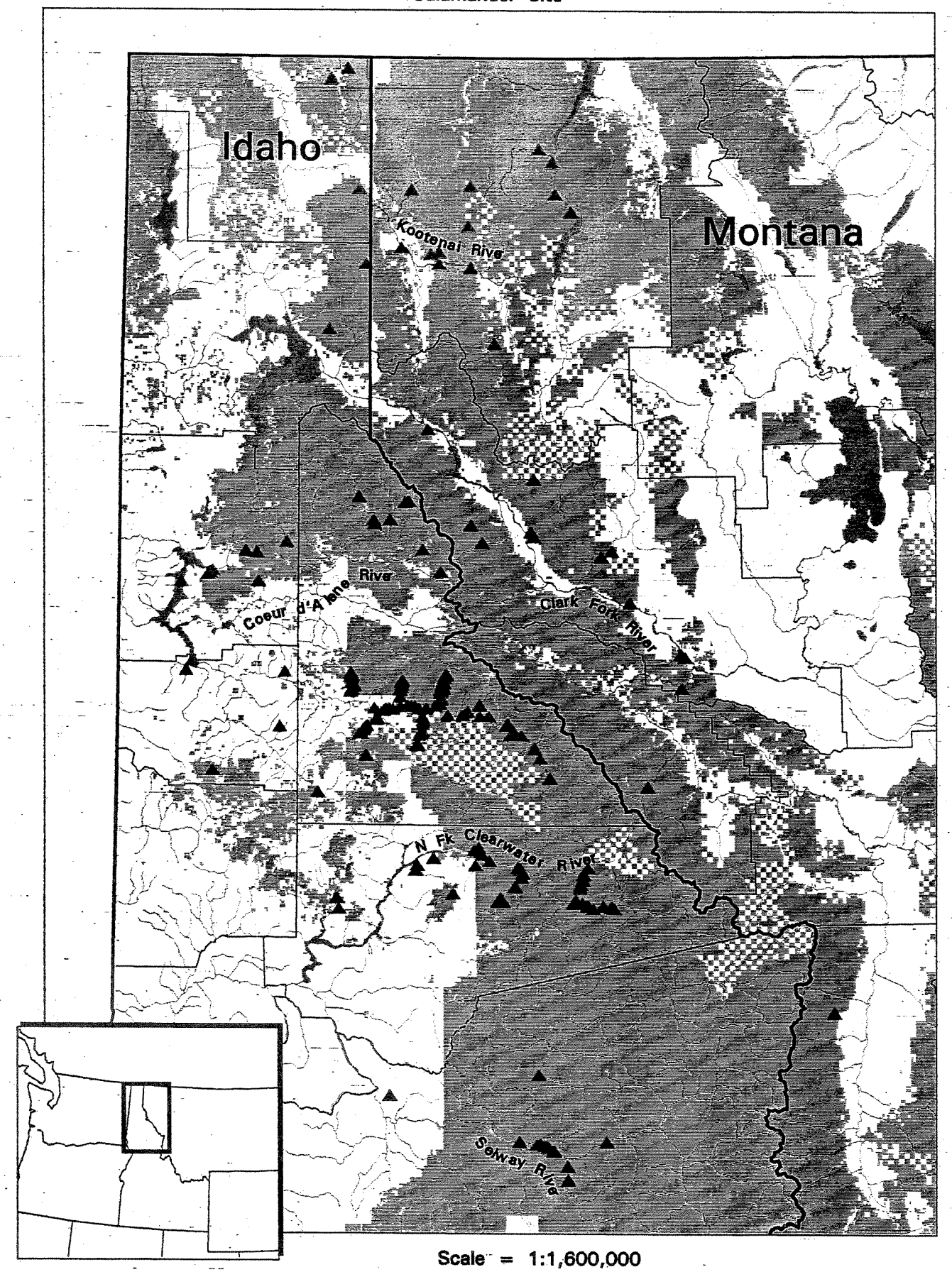
Wyman, R.L. 1990. What's happening to the amphibians? Cons. Biol. 4:350-352.

Appendix A

Occurences of Coeur d'Alene salamanders in Idaho and Montana, 1992

Plethodon idahoensis in Idaho & Montana

▲ Salamander Site



Scale = 1:1,600,000

0 10 20 30

Miles

Appendix B. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

Site Name	Type	Status[1]	Township	Range	Last year salamanders observed
NEZ PERCE NATIONAL FOREST					
Meadow Creek	seep	1	31N	9E	1989
Twentymile Bar	seep	1	32N	8E	1990
0.2 mi. E. of Glover Creek	seep	1	32N	9E	1990
Glover Creek	seep	2	32N	9E	1986
Unnamed Creek 1	stream	1	32N	9E	1990
3.5 mi. W. of Glover Creek	seep	1	32N	8E	1990
Cache Creek	stream	1	32N	8E	1990
Unnamed Creek 3	falls	1	31N	9E	1990
Falls Creek	stream	1	31N	9E	1990
Unnamed Creek 2	stream	1	31N	9E	1990
1.5 mi. W. Glover Creek	seep	1	32N	9E	1990
Cascade Creek	falls	1	32N	11E	1990
CLEARWATER NATIONAL FOREST					
Lochsa River	seep	1	34N	08E	1987
Elk River/Dent Acres	seep	1	39N	02E	1991
Elk Creek Falls	falls	1	39N	02E	1992
Flat Creek #2	seep	1	39N	07E	1991
Flat Creek #1	seep	1	39N	07E	1987
Kelly Creek Falls	falls	1	39N	10E	1985
Pie Creek #2	seep	1	39N	10E	1987
Pie Creek #1	seep	1	39N	10E	1987
Beaver Creek	stream	1	39N	6E	1987
Canyon Ranger Stn.	stream	2	40N	07E	1959

[1] Status: 1=extant, 2=unknown

Appendix B cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

CLEARWATER NATIONAL FOREST cont'd.

Site Name[1]	Type	Status[2]	Township	Range	Last year salamanders observed
Black Canyon #1	seep	1	39N	10E	1987
Black Canyon #2	seep	1	39N	10E	1987
Black Canyon #3	falls	1	39N	10E	1987
N. Fork Clearwater, 158	seep	1	39N	07E	1991
N. Fork Clearwater, 159	seep	1	40N	08E	1991
N. Fork Clearwater, 160	seep	1	40N	08E	1991
Clayton Creek #1	seep	1	39N	10E	1987
Clayton Creek #2	seep	1	39N	11E	1987
Clayton Creek #3	seep	1	39N	11E	1987
Beaver/Steep/Montana Creeks	falls	1	40N	06E	1987
Aquarius Campground	stream	2	40N	07E	1980
Quartz Creek	seep	1	40N	08E	1987
Quartz Creek, 161	seep	1	40N	08E	1991
Rock Creek	seep	1	40N	08E	1987
Elizabeth Creek	seep	1	40N	10E	1987
Fix Creek	seep	1	40N	10E	1987
Pete Ott Creek #2	seep	1	40N	10E	1987
Pete Ott Creek #1	seep	1	40N	10E	1987
Elizabeth Creek #2	seep	1	40N	10E	1987
Marquette Creek	stream	1	41N	06E	1987
Dog Creek	stream	1	41N	07E	1987
Fern Creek	stream	1	41N	07E	1987

[1] Conservation Data Center EO number follows name in multiple sites with the same name e.g. N. Fork Clearwater, **158**

[2] Status: 1=extant, 2=unknown

Appendix B cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

IDAHO PANHANDLE NATIONAL FORESTS - ST. JOE N. F.					
Site Name[1]	Type	Status[2]	Town-ship	Range	Last year salamanders observed
Emida Southwest	seep	2	43N	03E	1955
Clarkia	seep	1	43N	01E	1989
Ahrs Gulch	stream	1	46N	01E	1987
Big Creek	seep	1	46N	03E	1987
Big Creek, 126	seep	1	46N	03E	1992
Big Creek, 127	seep	1	46N	03E	1992
Big Creek, 128	seep	1	46N	03E	1992
Big Creek, 129	stream	1	46N	03E	1992
Big Creek, 130	seep	1	46N	03E	1992
Big Creek, 131	seep	1	46N	03E	1992
Big Creek, 132	seep	1	46N	03E	1992
Big Creek, 133	seep	1	46N	03E	1992
Big Creek, 134	seep	1	46N	03E	1992
Big Creek, 135	seep	1	46N	03E	1992
Big Creek, 136	seep	1	46N	03E	1992
Big Creek, 137	seep	1	46N	03E	1992
Marble Creek, 138	seep	1	45N	03E	1992
Marble Creek, 139	seep	1	45N	03E	1992
Boulder Creek	seep	1	45N	04E	1992
Marble Creek, 141	seep	1	45N	03E	1992
Marble Creek, 142	seep	1	45N	03E	1992

[1] Conservation Data Center EO number follows name in multiple sites with the same name e.g. N. Fork Clearwater, **158**

[2] Status: 1=extant, 2=unknown

Appendix B. cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

IDAHO PANHANDLE NATIONAL FORESTS - ST. JOE N. F., cont'd.					
Site Name	Type	Status[1]	Township	Range	Last year salamanders observed
Marble Creek, 143	seep	1	45N	03W	1992
Marble Creek, 144	seep	1	45N	03E	1992
Marble Creek, 145	seep	1	45N	03E	1992
Marble Creek, 146	seep	1	45N	03E	1992
Marble Creek, 147	seep	1	44N	03E	1992
Marble Creek, 148	seep	1	44N	03E	1992
Marble Creek, 149	stream	1	44N	03E	1992
Unnamed trib. Marble Cr.	seep	1	44N	03E	1992
Slate Creek, 095	seep	1	46N	04E	1991
Slate Creek, 096	seep	1	46N	04E	1991
Slate Creek, 097	seep	1	46N	04E	1991
Slate Creek, 098	seep	1	46N	04E	1991
Slate Cr./Fume Cr. confluence	seep	1	46N	04E	1991
Fishhook Creek	seep	1	45N	05E	1991
Fishhook Creek, 044	seep	1	44N	05E	1991
Fishhook Creek, 086[2]	seep	1	44N	05E	1991
West Fork Fishhook Cr.	seep	1	44N	05E	1991
Lick Cr./Wawa Cr. conf.	seep	1	44N	05E	1991
Fishhook Creek, 085	seep	1	45N	05E	1991
Fishhook Creek, 086[2]	seep	1	45N	05E	1991
Fishhook Creek, 088	seep	1	44N	05E	1991

[1] Conservation Data Center EO number follows name in multiple sites with the same name e.g. N. Fork Clearwater, 158
[2] Site located partially on Plum Creek Timber Co. Land
[3] Status: 1=extant, 2=unknown

Appendix B cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

IDAHO PANHANDLE NATIONAL FORESTS - ST. JOE N. F., cont'd.					
Site Name	Type	Status[1]	Township	Range	Last year salamanders observed
Fishhook Creek, 087	seep	1	45N	05E	1991
Fishhook Creek, 089	seep	1	45N	05E	1991
Fishhook Creek, 090	seep	1	45N	05E	1991
Avery	seep	1	45N	05E	1991
N. Fork St. Joe R. #1	seep	1	45N	05E	1987
N. Fork St. Joe R. #2	seep	1	45N	05E	1991
N. Fork St. Joe R., 100	seep	1	46N	05E	1991
N. Fork St. Joe R./ Miller Creek	seep	1	46N	05E	1991
N. Fork St. Joe R., 102	seep	1	45N	05E	1991
N. Fork St. Joe R., 103	seep	1	46N	05E	1991
N. Fork St. Joe R./ Hammond Cr.	seep	1	46N	05E	1991
N. Fork St. Joe R./ Kyle Cr.	seep	1	46N	05E	1991
N. Fork St. Joe R., 106	seep	1	46N	05E	1991
N. Fork St. Joe R., 107	seep	1	46N	05E	1991
N. Fork St. Joe, 108	seep	1	46N	05E	1991
N. Fork St. Joe R., 109	seep	1	46N	05E	1991
N. Fork St. Joe R., 110	seep	1	46N	05E	1991
N. Fork St. Joe R., 111	seep	1	46N	05E	1991
N. Fork St. Joe, 112	seep	1	46N	06E	1991
N. Fork St. Joe R., 113	seep	1	46N	06E	1991

[1] Conservation Data Center EO number follows name in multiple sites with the same name e.g. N. Fork Clearwater, **158**
2 Status: 1=extant, 2=unknown

Appendix B cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

IDAHO PANHANDLE NATIONAL FORESTS - ST. JOE N. F., cont'd.					
Site Name[1]	Type	Status[2]	Township	Range	Last year salamanders observed
Siwash Creek	stream	1	45N	06E	1987
Bird Creek/St. Joe River	seep	1	45N	07E	1978
Bird Creek	seep	1	45N	07E	1990
Malin Creek West	seep	1	45N	07E	1991
Quartz Creek, 117	seep	1	45N	07E	1991
Quartz Creek, 118	seep	1	45N	07E	1991
Quartz Creek, 119	seep	1	45N	07E	1991
Bluff Creek, 120	seep	1	44N	08E	1991
Bluff Creek, 121	seep	1	44N	08E	1991
Shady Creek	seep	1	44N	08E	1991
Midget Creek	seep	1	44N	09E	1991
St. Joe River #2	seep	1	45N	04E	1991
St. Joe River #3	seep	1	45N	04E	1991
St. Joe River #4	seep	1	45N	05E	1991
St. Joe River, 114	seep	1	45N	06E	1991
St. Joe River, 115	seep	1	45N	06E	1991
St. Joe River, 122	seep	1	44N	08E	1991
Gold Creek Campground	seep	1	44N	08E	1991
Red Ives Ranger Stn.	seep	1	43N	09E	1991

[1] Conservation Data Center EO number follows name in multiple sites with the same name e.g. N. Fork Clearwater, **158**

2 Status: 1=extant, 2=unknown

Appendix B cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

Site Name[1]	Type	Status[2]	Township	Range	Last year salamanders observed
IDAHO PANHANDLE NATIONAL FORESTS - COEUR D'ALENE N. F.					
Beauty Creek	stream	1	49N	03W	1991
Beauty Bay	stream	1	49N	03W	1985
Fourth of July Creek	mine shaft	2	49N	01W	1957
Marie Creek	stream	1	50N	01W	1989
Skitwish Creek	stream	1	50	01W	1989
Little N. Fork Coeur d'Alene River	seep	1	50N	01E	1987
S. F. Potter Creek	stream	1	51N	01E	1991
Coeur d'Alene River #1	seep	1	51N	03E	1987
Coeur d'Alene River #2	seep	1	51N	03E	1987
Cardinal Creek	seep	1	52N	03E	1987
Shoshone Creek	seep	1	51N	04E	1988
Bear Gulch	seep	1	49N	05E	1991
East Fork Eagle Cr.	seep	1	50N	05E	1991
Lewelling Creek	falls	1	52N	01W	1992
Falls Creek, 153	seep	1	52N	04E	1991
Falls Creek, 154	seep	1	52N	04E	1991
IDAHO PANHANDLE NATIONAL FORESTS-KANIKSU NATIONAL FOREST					
S. Fork Wellington Cr.	falls	2	57N	02E	1965
Frezcat Creek	seep	1	59N	03E	1988
Caboose Creek	stream	1	61N	03E	1989
Little Hellroaring Falls	falls	1	65N	02E	1989
Copper Falls	falls	1	65N	02E	1989

[1] CDC EO number follows name in multiple sites with the same number
[2] Status: 1=extant, 2=unknown

Appendix B cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

Site Name[1]	Type	Status[2]	Township	Range	Last year salamanders observed
BUREAU OF LAND MANAGEMENT					
Wolf Lodge Bay	seep	1	49N	03W	1991
St. Joe River, 078	seep	1	45N	04E	1991
St. Joe River, 079	seep	1	45N	04E	1991
St. Joe River, 081	seep	1	45N	04E	1991
Slate Creek, 094	seep	1	45N	04E	1991
STATE OF IDAHO					
Chatcolet South	stream	2	46N	04W	1957
Benton Butte	seep	1	40N	05E	1979
Elk River, 157	seep	1	39N	02E	1991
U.S. ARMY CORPS					
Benton Creek	stream	1	40N	05E	1976
POTLATCH CORPORATION					
W. Fork Benton Cr.	stream	1	40N	05E	1987
Marble Creek	seep	1	45N	03E	1992
DAW FOREST PRODUCTS					
St. Joe River #1	seep	1	45N	03E	1987

[1] Conservation Data Center EO number follows name in multiple sites with the same name e.g. N. Fork Clearwater, **158**

2 Status: 1=extant, 2=unknown

Appendix B cont'd. Location and status of known Coeur d'Alene salamander sites in Idaho, 1992.

Site Name	Type	Status[1]	Township	Range	Last year salamanders observed
PLUM CREEK TIMBER COMPANY					
Fishhook Creek, 091	seep	1	44N	05E	1991
St. Joe River, 082	seep	1	45N	04E	1991
Flemming Cr.	seep	1	45N	04E	1991
Olson Gulch	seep	1	45N	05E	1991
PRIVATE INDIVIDUAL OR CORPORATION					
Hoyt Creek	seep	1	45N	04E	1991
Driftwood Point	seep	1	49N	04W	1989

[1] Conservation Data Center EO number follows name in multiple sites with the same name e.g. N. Fork Clearwater, **158**

2 Status: 1=extant, 2=unknown

Appendix C. Location and status of known Coeur d'Alene salamander populations in Montana, 1992.

Site Name	Type	Status[1]/ Size[2]	Township	Range	Last year salamanders observed
KOOTENAI NATIONAL FOREST, REXFORD RANGER DISTRICT					
Mid-Koocanusa	seep/ stream	1/l	33N	29W	1989
Koocanusa - north	seep	1/l	34N	29W	1989
Ziegler Mountain	seep	1/s	33N	28W	1988
KOOTENAI NATIONAL FOREST, LIBBY RANGER DISTRICT					
Big Hoodoo Mountain	stream	1/s	29N	31W	1989
Kootenai Falls - east	stream	1/m	31N	32W	1989
KOOTENAI NATIONAL FOREST, THREE RIVERS RANGER DISTRICT					
Kootenai Falls - west	seep	1/l	31N	33W	1989
Yaak Falls	seep	1/m	33N	33W	1988
Surprise Gulch	stream	1/m	31N	33W	1989
Koot Creek	stream	1/m	31N	33W	1988
KOOTENAI NATIONAL FOREST, CABINET RANGER DISTRICT					
Big Beaver Creek	seep	1/s	22N	31W	1989
Sims Creek/ Vermillion River	seep	1/s	24N	30W	1988
West of Noxon	seep/ stream	1/m	26N	33W	1989
White Pine Creek	seep	1/s	23N	32W	1988

[1] Status: 1=extant, 2=unknown

[2] Size: s=Small. Single seeps less than 100 m^2, 0-5 salamanders observed per visit under optimum survey conditions. m= Medium. Seeps 100-200 m^2 and/or stream reaches of 50 m or less, 6-10 salamanders observed per visit under optimum survey conditions. l=Large. Extensive habitat available, seeps >200 m^2 and/or stream reaches >50 m in length, >10 salamanders observed per visit under optimum survey conditions.

Appendix C cont'd. Location and status of known Coeur d'Alene salamander populations in Montana, 1992.

Site Name	Type	Status[1]/ Size[2]	Township	Range	Last year salamanders observed
LOLO NATIONAL FOREST, SUPERIOR RANGER DISTRICT					
Trout Creek	seep	1/s	15N	27W	1988
LOLO NATIONAL FOREST, PLAINS/THOMPSON FALLS RANGER DISTRICT					
Cascade Creek	falls	1/l	18N	25W	1988
Paradise	seep	1/m	19N	25W	1988
Thompson River/Barktable	seep	1/m	22N	27W	1989
Priscilla Gulch	stream	1/s	22N	28W	1989
Cougar Gulch	stream	1/s	23N	30W	1988
Big Hole Mountain	seep	2	21N	27W	1988
BITTERROOT NATIONAL FOREST, STEVENSVILLE RANGER DISTRICT					
Sweathouse Creek	falls	2/s	8N	21W	1987
CHAMPION INTERNATIONAL					
Pipe Creek	seep	1/l	34N	31W	1989
Woodman Creek	stream	2/s	12N	21W	_
PRIVATELY OWNED (INDIVIDUAL OR CORPORATE)					
North of Troy	stream	1/s	32N	34W	1987
Cougar Mine	mine	1/s	30N	23W	1988
Simmons	falls	1/l	19N	25W	1988
Weeksville	seep	1/s	21N	27W	1991

[1] Status: 1=extant, 2=unknown

[2] Size:s= Small. Single seeps less than 100 m^2, 0-5 salamanders observed per visit under optimum survey conditions. m= Medium. Seeps 100-200 m^2 and/or stream reaches of 50 m or less, 6-10 salamanders observed per visit under optimum survey conditions. l=Large. Extensive habitat available, seeps >200 m^2 and/or stream reaches >50 m in length, >10 salamanders observed per visit under optimum survey conditions.

Appendix D
Coeur d'Alene Salamander
Survey/Monitoring Report Form

Coeur d'Alene Salamander
Survey/Monitoring Report Form

Location(Site Name)_____ Date_____

Quad Name/Code _____ TRS_____

Area Surveyed (m^2) _____

Time Spent_____(person minutes) Photo Y__ N__

Specimen(s) Y__ N__ Where Deposited_____

Observations (numbers, size, etc.)_____

_____

Behavioral Notes_____

_____

Elevation_____ Slope (%) _____ Aspect_____Cover (%)_____

Cover type/habitat description_____

_____

_____

Weather_____

Air Temperature (F): Start _____ End _____

Water Flow_____ Water Temp_____ Days since last rain_____

Landowner_____

Site Condition/Threats_____

Date(s) of previous visit(s)_____

Observer(s)_____

Address_____Phone_____

Attach a copy of appropriate section of topographic map with site location marked on it if this is a new site.
Send copies to the Montana Natural Heritage Program or the Idaho Conservation Data Center.